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European Patent Office  
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(11)

**EP 1 116 575 A2**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
18.07.2001 Bulletin 2001/29

(51) Int Cl.7: **B29C 70/52**(21) Application number: **01100389.4**(22) Date of filing: **05.01.2001**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE TR**  
Designated Extension States:  
**AL LT LV MK RO SI**

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(30) Priority: **11.01.2000 JP 2000002437**

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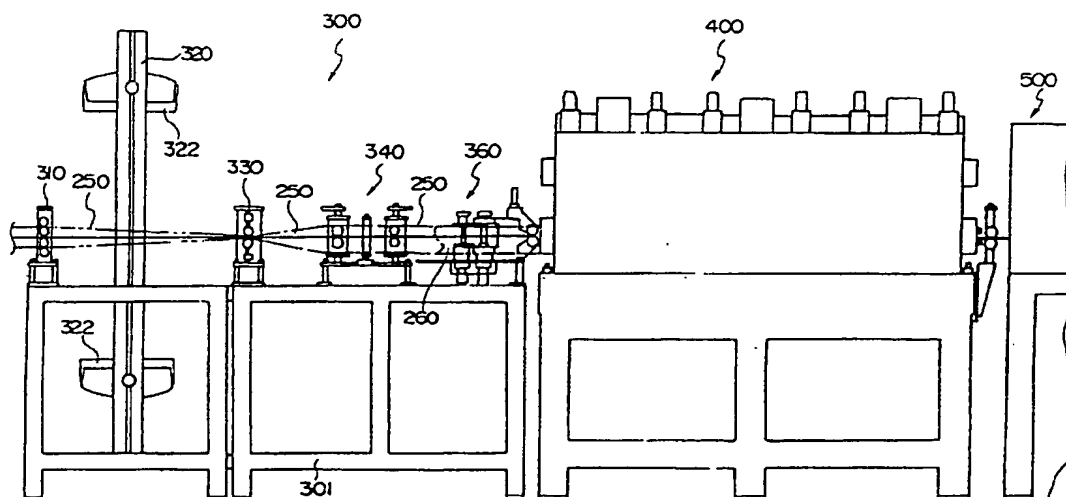
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**(54) Continuous forming device of h-shaped frp member**

(57) A preimpregnated sheet material (250) impregnated with thermosetting resin is spooled around a bobbin, and two bobbins (200) positioned one above the other constituting one unit is provided to feed the materials sequentially to a crease forming device (310), an open-trapezoid-shape forming device (330) and a U-shape forming device (340) where the materials are bent. The preimpregnated sheet member bent to form a U-shape is vertically mounted on another U-shaped

member to form the shape of an H, and to the surfaces of said H-shaped member are provided release films (260) before the member is transferred to a hot press device (400). Said sheet material heated and pressed by the hot press device (400) is then heated for a predetermined time at an after-cure device, where thermosetting of the material is completed. The produced H-shaped member is then intermittently pulled out by a haulage device and cut into predetermined lengths.

Fig. 5

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**Description****FIELD OF THE INVENTION**

[0001] The present invention relates to a forming device of a preimpregnated material produced by impregnating thermosetting resin to carbon fiber or glass fiber and the like.

**DESCRIPTION OF THE RELATED ART**

[0002] A technique for utilizing preimpregnated material produced by impregnating thermosetting resin such as epoxy resin and phenolic resin to long fiber such as carbon fiber and glass fiber to form a product having the desired cross-sectional shape by heating and forming the material is known. Since carbon fiber and glass fiber have great strength, especially tensile strength, per unit weight, a composite material formed by laminating fiber material with the fibers oriented in vertical, horizontal and diagonal directions can be used to manufacture products having light weight and relatively high strength and elasticity. Therefore, the material is widely utilized in forming aircraft and other industrial products.

[0003] The material used for forming the desired shape can be manufactured by arranging carbon fiber or glass fiber impregnated with thermosetting resin in parallel orientation to form one layer, by using fabric produced from these fibers to form one layer, or by laminating a plural number of such layers further positioning roving of these fibers between layers if necessary to produce the forming member. The forming method and forming device of this material includes feeding plural strip-shaped preimpregnated materials from bobbins, heating and pressurizing the material by heated upper and lower molds of a hot press device to form a predetermined cross-sectional shape, and then curing the formed product in a curing furnace and completing the product. During the above-mentioned forming steps, the product is continuously pulled (hauled) by a haulage device mounted to the downstream side in the forming device so as to convey the product in the forming device.

[0004] However, the problems of the conventional forming method and device explained above is that notable friction resistance is generated when pulling the formed product by the haulage device, causing abrasion such as cutting or curling of the fiber. Furthermore, since the hauling force of the haulage device is strong, it is difficult according to the conventional method and device to form a thin product. Therefore, in order to solve these problems, the present applicants proposed, in Japanese Patent Laid-Open Application No. 2-102029, a device for intermittently transmitting strip-shaped preimpregnated material while bending the material with a mold so as to form a channel-shaped cross section, and hot-pressing the material to form a product with the desired shape. The device enables to continuously form structural members having linear trajectory with L-

shaped or U-shaped cross section. The forming device of this kind is also disclosed in the specification of U. S. Patent No. 4,151,030.

**SUMMARY OF THE INVENTION**

[0005] The present invention provides a device for efficiently forming H-shaped members made of FRP with advanced performance that can be used for underfloor beam member or reinforcement of main and tail planes of an aircraft.

[0006] The continuous forming device of an H-shaped FRP member according to the present invention comprises a device for mounting a plural number of bobbins having strip-shaped preimpregnated material produced by impregnating thermosetting resin to carbon fiber or glass fiber and the like spooled thereto, a device for providing tension when pulling the preimpregnated material out from the bobbin, a device for shaping the preimpregnated member to a predetermined H-shape, a device for feeding release films from four (upper, lower, left and right) sides, a press device for providing heat and pressure to the preimpregnated member from four sides, a heating furnace for after-curing the preimpregnated member, a device for hauling and holding the preimpregnated member, and a device for cutting the cured product to predetermined lengths.

[0007] Further, the device for shaping the strip-shaped preimpregnated member provided from the bobbins to form a predetermined H-shape comprises a device for forming two creases to two sheets of preimpregnated material in the longitudinal direction, a device for bending the sheet at the creases to form an open-trapezoid-shaped cross section, and a device for forming a U-shaped cross section and further superposing two U-shaped preimpregnated members to form an H-shape.

[0008] Moreover, the haulage device is interlocked with upper, left and right molds of the press device so that the preimpregnated member is heated and pressed for a predetermined time before being hauled for a predetermined length, and the press device is equipped with means for controlling the sequence for opening and closing the upper, left and right molds.

**BRIEF DESCRIPTION OF THE DRAWINGS****[0009]**

FIG. 1 is a perspective view showing the exterior of the H-shaped member;

FIG. 2 is a cross-sectional view of the H-shaped member;

FIG. 3 is an explanatory view showing the outline of the continuous forming device of the H-shaped member;

FIG. 4 is a perspective view showing the material feeding device in the continuous forming device of

the H-shaped member;

FIG. 5 is an explanatory view showing the step for forming the material to the shape of an H;

FIG. 6 is an explanatory view of the crease forming device;

FIG. 7 is an explanatory view showing the open-trapezoid-shape forming device;

FIG. 8 is an explanatory view showing the U-shape forming device;

FIG. 9 is an explanatory view showing the mold structure of the hot press device;

FIG. 10 is an explanatory view showing the haulage device and the cutting device of the sheet material; and

FIG. 11 is a chart showing the sequence of operation of the present device.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0010]** FIG. 1 is a perspective view showing the appearance of the H-shaped member formed according to the present invention, and FIG. 2 is a cross-sectional view thereof.

**[0011]** The H-shaped member shown as a whole by reference number 1, comprising both side walls 10, 10 and a rib 20 that connects the center area of the side walls, is manufactured by heat-forming a preimpregnated material, which is made by impregnating thermosetting resin to FRP (fiber reinforced plastics: plastic material reinforced with carbon fiber or glass fiber and the like).

**[0012]** The H-shaped member 1 is formed by laminating a plurality of preimpregnated members P1, P2, and a surface member P3. The preimpregnated member P1 is formed for example by alternately laminating preimpregnated sheets, the orientation of the fiber in each sheet arranged at an angle of 45 degrees to the longitudinal direction of the member. The preimpregnated member P2 is formed by laminating preimpregnated materials having fiber arranged in one direction. By selecting the orientation of the fiber appropriately, the H-shaped member can be formed to provide the most appropriate strength required for various applications. During the forming process, a release film F is superposed on the upper surface, the lower surface and both side surfaces of the member.

**[0013]** FIG. 3 shows an outline of the continuous forming device according to the present invention.

**[0014]** The forming device shown as a whole by reference number 100 is equipped with a sheet-type material supply device 200, a forming device 300 for bending the sheets to form an H-shape, a hot press device 400, an after-cure device 500 which is a heating furnace, a sheet clamping (holding) device 600, and a sheet haulage device 700.

**[0015]** An appropriate cutter not shown is equipped downstream from the sheet haulage device 700 for cut-

ting the product to appropriate lengths.

**[0016]** FIG. 4 is a perspective view showing the details of the material supply device 200.

**[0017]** The material supply device 200 comprises a spindle 210 mounted on a stand 210, and a bobbin 230 is rotatably mounted thereto. A preimpregnated sheet 250 with a release film 240 laminated thereto is spooled onto the bobbin 220. Since the preimpregnated sheet 250 is tacky, it is spooled together with a release film 240, and the release film 240 is removed from the surface of the preimpregnated sheet 250 at the time the sheet is supplied to the forming device.

**[0018]** The release film 240 is removed and spooled by an appropriate reel device 245.

**[0019]** Six bobbins 230 are shown according to the present invention, but the number of the bobbins should be selected appropriately according to the specification of the H-shaped member to be formed. Moreover, release films are provided to the upper and lower surfaces of the sheet material.

**[0020]** FIG. 5 shows devices for forming the provided preimpregnated sheet member 250 to the shape of an H, and to transmit the shaped member to a hot press and an after-cure device.

**[0021]** The device 300 for bending the sheet members 250 to form an H is equipped with a device 310 for providing creases to the sheet members 250, an infrared heater 320, a device 330 for bending the sheet members to form an open-trapezoid-shape, a device 340 for bending the sheet members 250 to form a U-shape, and a device 360 for laminating preimpregnated sheet materials 260 to the side walls of the H-shaped sheet materials 250.

**[0022]** The formed preimpregnated sheet material is heated and pressure-formed in a hot press device 400, before being transmitted to an after-cure device 500.

**[0023]** FIG. 6 shows a crease-forming device 310, wherein two rolls 312 and 314 placed to face one another on a frame 311 is formed as a unit, and two units are equipped on the frame with one unit placed above the other.

**[0024]** The first roll 312 comprises protruded regions 313 having the shape of abacus beads, and the second roll 314 comprises groove regions 315 for receiving the protruded regions 313.

**[0025]** When traveling between the rolls 312 and 314, the sheet members 250 are provided with creases 250a.

**[0026]** The sheet members 250 provided with creases 250a are then fed to the open-trapezoid-shape forming device 330.

**[0027]** At this stage, the sheet members 250 travel through an infrared heater 320, which provides appropriate flexibility to the sheet members. The infrared heater 320 is equipped with heater units 322 placed above and under the sheet members 250.

**[0028]** The open-trapezoid-shape forming device 330 shown in FIG. 7 comprises a frame 331 supporting rolls 334 having horizontal rotation axes and rolls 332 having

tilted rotation axes, for bending the sheet members 250 traveling therethrough to form an open-trapezoid shape with the creases 250a positioned inward.

[0029] The sheet materials 250 each bent to form an open-trapezoid shape is then conveyed to the U-shape forming device 340 shown in FIG. 8. The U-shape forming device 340 comprises belts 343 rotatably supported by axes 342 perpendicularly mounted on a frame 341, and rolls 344 rotatably supported by horizontal axes.

[0030] When the open-trapezoid shaped sheet members 250 conveyed to the device 340 travel between the belts and rolls, each member is bent into a U-shape, and the two U-shaped sheets 250 are mutually fixed in the inverse direction to form an H-shape.

[0031] Next, release films 260 are laminated on both side surfaces of the H-shaped member at the station 360 before it is conveyed to the hot press device 400.

[0032] FIG. 9 is an explanatory view showing the mold structure of the hot press device 400.

[0033] The hot press device 400 is equipped with a lower mold 410 and an actuator 422 for driving an upper mold 420 opposing to the lower mold 410. On both side areas of the upper and lower molds are positioned side molds 430 that are driven by actuators 432.

[0034] The after-cure device 500 is a heating furnace for heating the H-shaped and pressed preimpregnated sheet member at a predetermined temperature for a predetermined time, in order to accelerate the thermosetting of the resin.

[0035] FIG. 10 is an explanatory view showing the clamp of the sheet material mounted near the output of the after cure device 500, a haulage device, and a cutting device.

[0036] The H-shaped member 270, in other words, the product that has completed the curing process by the after-cure device 500, passes through the product clamping device 600 and the haulage device 700.

[0037] The clamping device 600 is equipped with a clamping means 610 for gripping the product 270 with an actuator 620, and while the haulage device 700 is not operated, the clamping means constantly holds the product 270. Since the area near the bobbin feeding the preimpregnated sheet material 250 is provided with a driving force that constantly pulls the preimpregnated sheet 250 back toward the bobbin so that tension is constantly provided to the sheet material 250 during the forming process, the clamping means prevents the product from being pulled back toward the bobbin by the tension.

[0038] The haulage device 700 is equipped with a gripper 710 that grips the product 270 through the operation of the actuator 720, and the device 700 is slidably supported by a linear guide 730.

[0039] The cylinder 740 drives the piston rod 750, and the piston rod 750 drives the feeding device toward the arrow A direction through a connecting unit 760. By the operation of the haulage device 700, the product 270 is hauled and conveyed intermittently.

[0040] The cutting device 800 comprises a rotary cutting blade 840 that is driven by a motor through a transmission 820, and through the actuator 830, the rotary cutting blade 840 descends and separates the product 270.

[0041] When the product 270 formed into a strip-shape reaches a predetermined length, the cutting device 800 is activated and the product 270 is cut into predetermined sizes.

[0042] For example, by detecting the position of the front end of the product 270 using a proximity switch and the like for activating the cutting device, the separating of the products 270 can be performed automatically.

[0043] FIG. 11 is a drawing showing the operational sequence of the hot press device 400, the clamping device 600, and the feeding (haulage) device 700.

[0044] The upper mold of the press is closed before the left and right side molds of the press are closed, and the product is held in this position for a predetermined time, thereby completing the hot press process.

[0045] During this time, the clamping device 610 of the product is closed, maintaining grip of the product.

[0046] After holding the product by closing the haulage device and the clamping device 710, the cylinder 740 is driven to move the clamping device 710 so as to convey the product 270.

[0047] Furthermore, the haulage device and the clamping device described in the above-mentioned preferred embodiment are merely one example of devices that can be used in the present invention, and any appropriate device for hauling and gripping the product, such as those using rollers or caterpillars, can also be used.

[0048] As explained, the present invention enables to form H-shaped members made of FRP continuously and automatically.

## Claims

1. A continuous forming device of an H-shaped FRP member for forming semi-hardened preimpregnated members produced by impregnating thermosetting resin to carbon fiber or glass fiber and the like into a predetermined H-shape, said forming device comprising:

a device for mounting a plural number of bobbins having strip-shaped preimpregnated material spooled thereto;

a device for providing tension when pulling said preimpregnated material out from said bobbin;

a device for shaping said preimpregnated member to a predetermined H-shape;

a device for feeding release films from four (upper, lower, left and right) sides;

a press device for providing heat and pressure to said preimpregnated member from said four

sides;

a heating furnace for after-curing said preimpregnated member;

a device for hauling and holding said preimpregnated member; and

a device for cutting the cured product to predetermined lengths.

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2. A continuous forming device of an H-shaped FRP member according to claim 1, wherein said device for shaping said strip-shaped preimpregnated member provided from said bobbins to form a predetermined H-shape comprises a device for forming two creases to one or more sheets of preimpregnated material in the longitudinal direction, a device for bending said sheet at said creases to form an open-trapezoid-shaped cross section, and a device for forming a U-shaped cross section and further superposing two U-shaped preimpregnated members to form an H-shape.
3. A continuous forming device of an H-shaped FRP member according to claim 1, wherein said haulage device is interlocked with upper, left and right molds of said press device so that said preimpregnated member is heated and pressed for a predetermined time before being hauled for a predetermined length.
4. A continuous forming device of an H-shaped FRP member according to claim 1, wherein said haulage device is interlocked with upper, left and right molds of said press device so that said preimpregnated member is heated and pressed for a predetermined time before being hauled for a predetermined length; and said press device is equipped with means for controlling the sequence for opening and closing said upper, left and right molds.

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Fig. 1

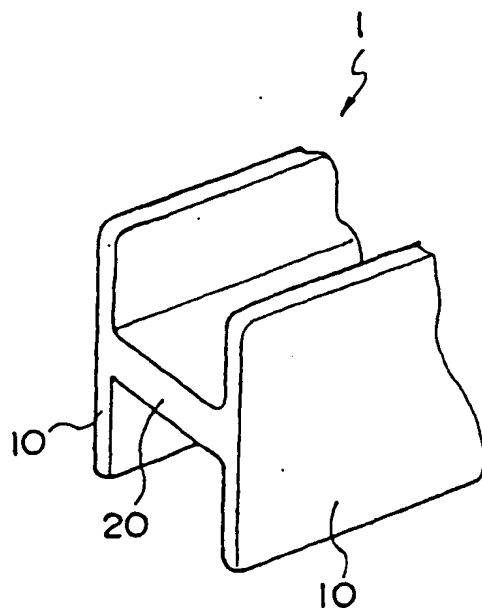


Fig. 2

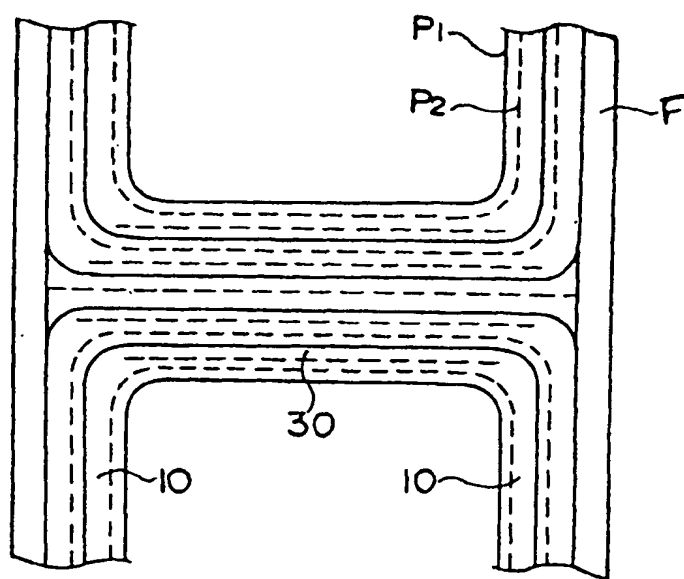


Fig. 3

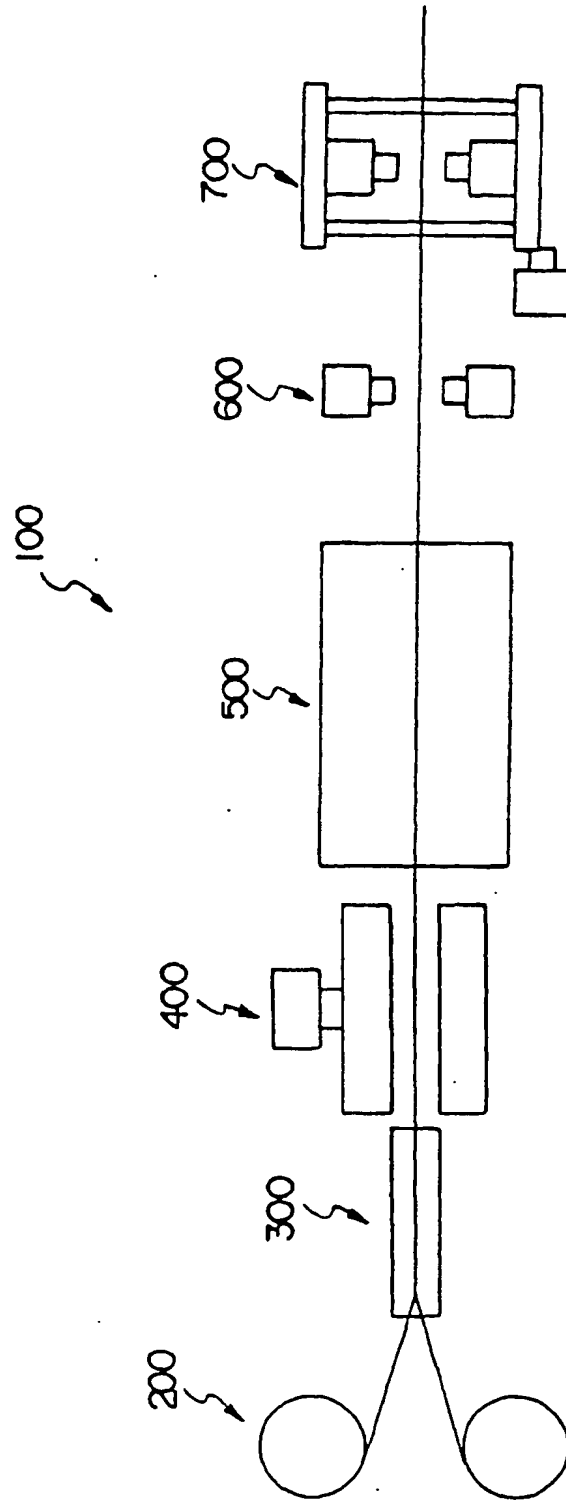


Fig. 4

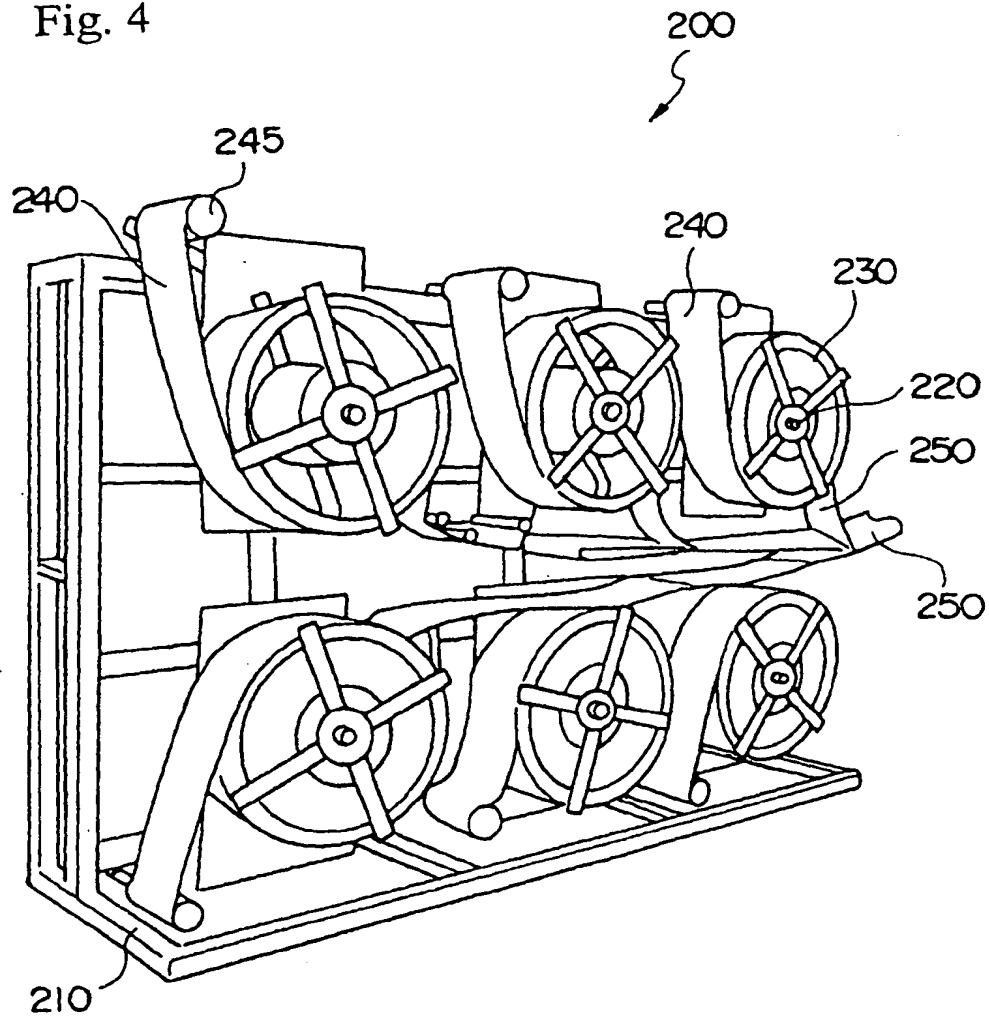




Fig. 5

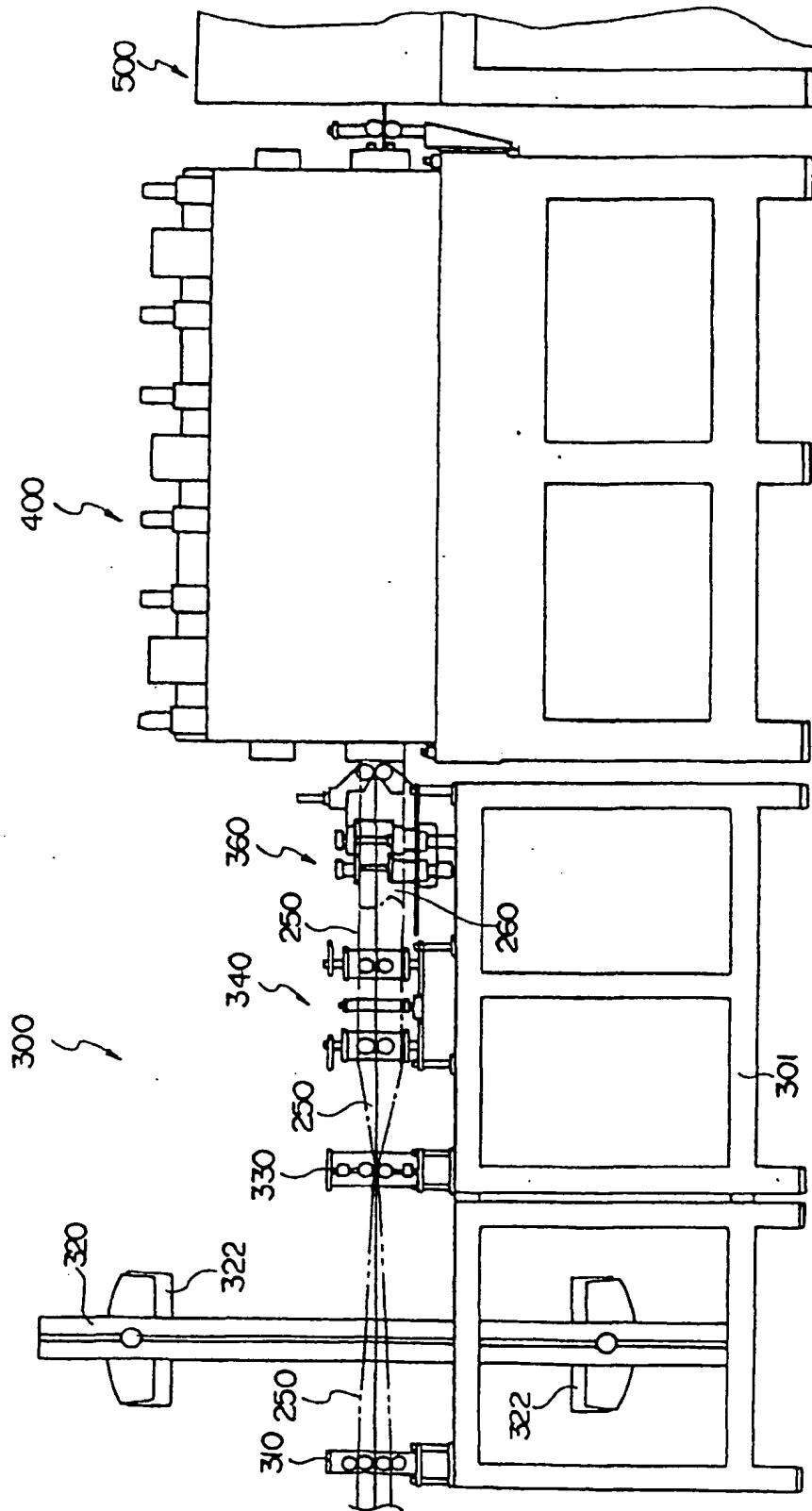


Fig. 6

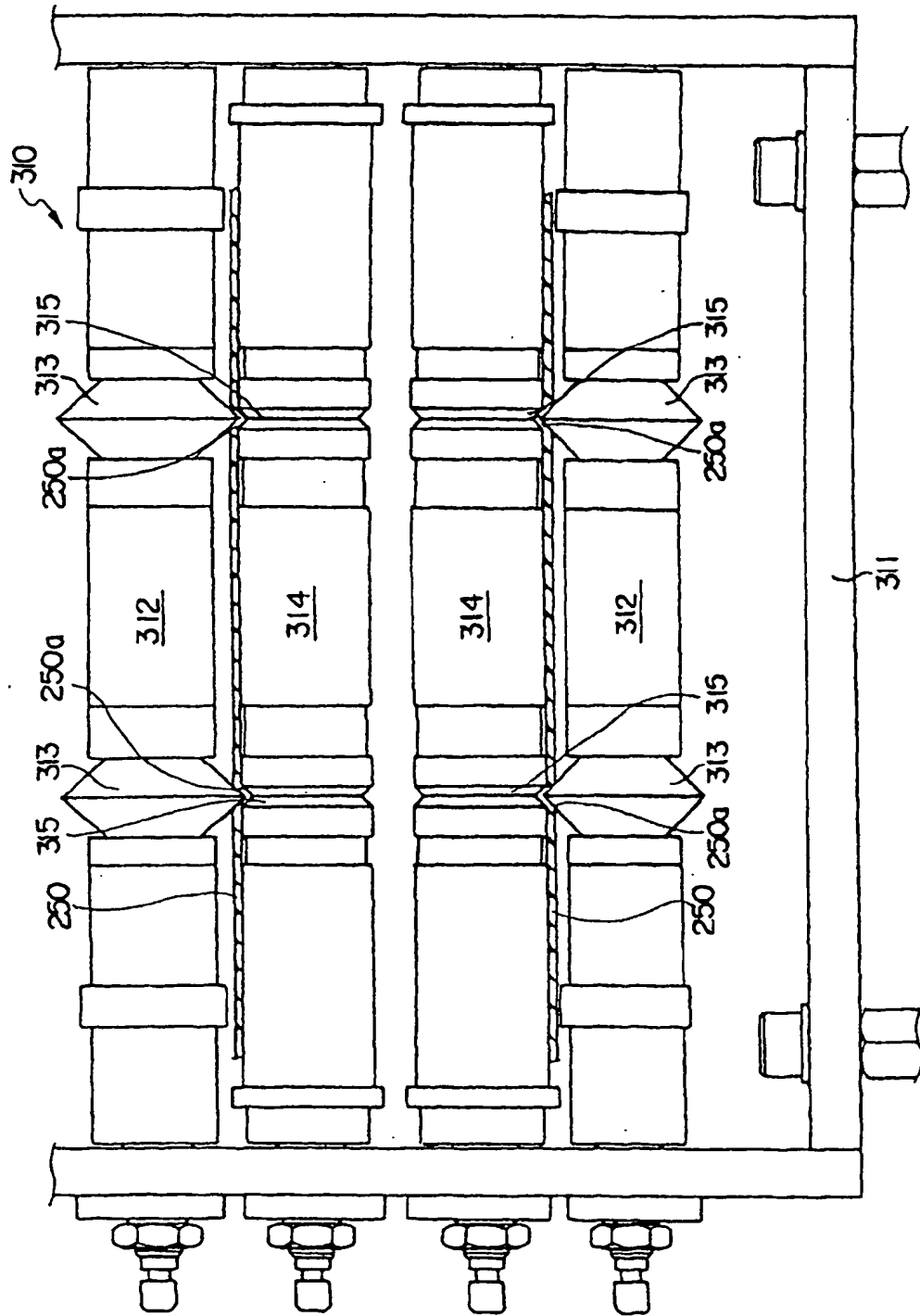


Fig. 7

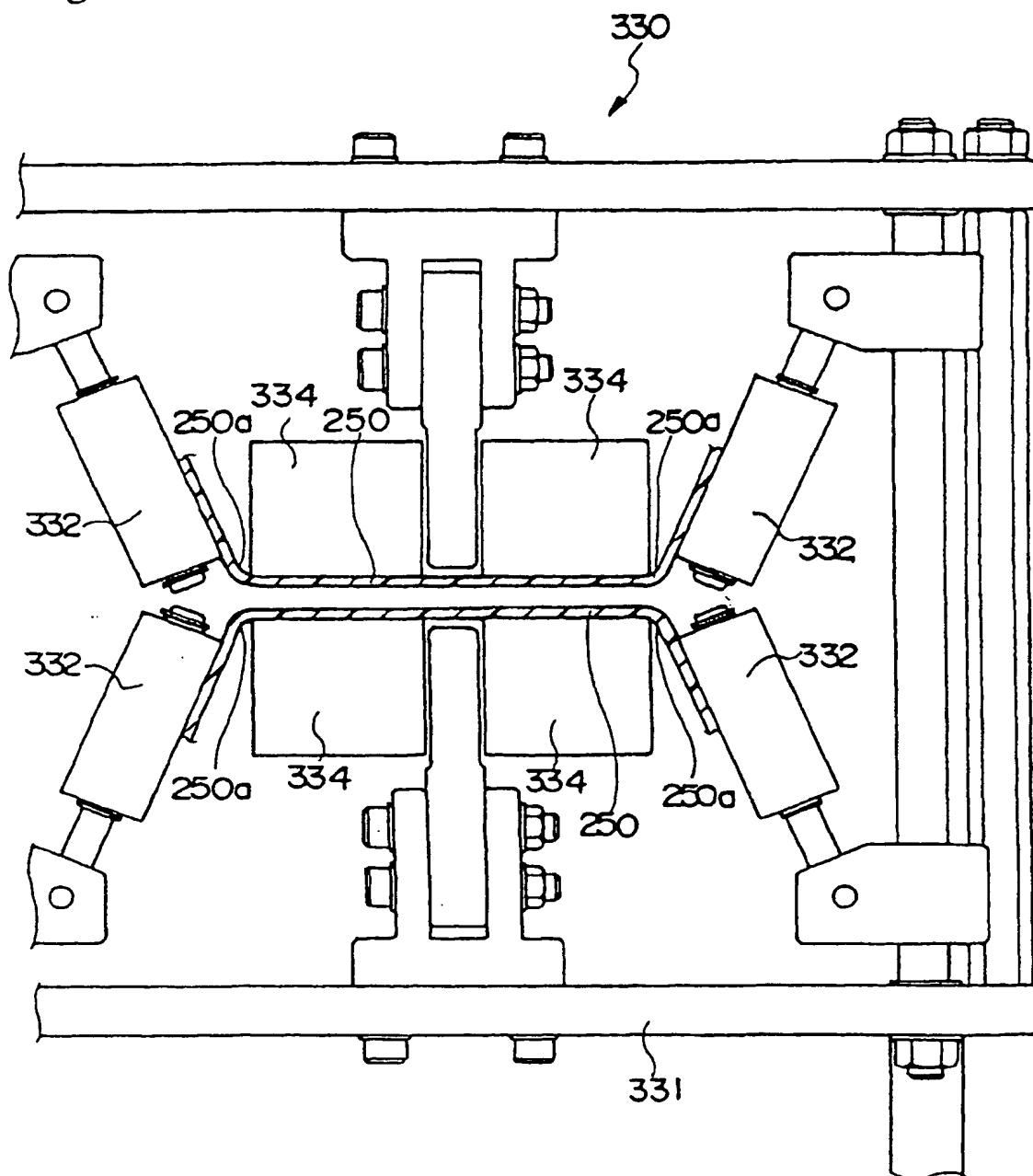


Fig. 8

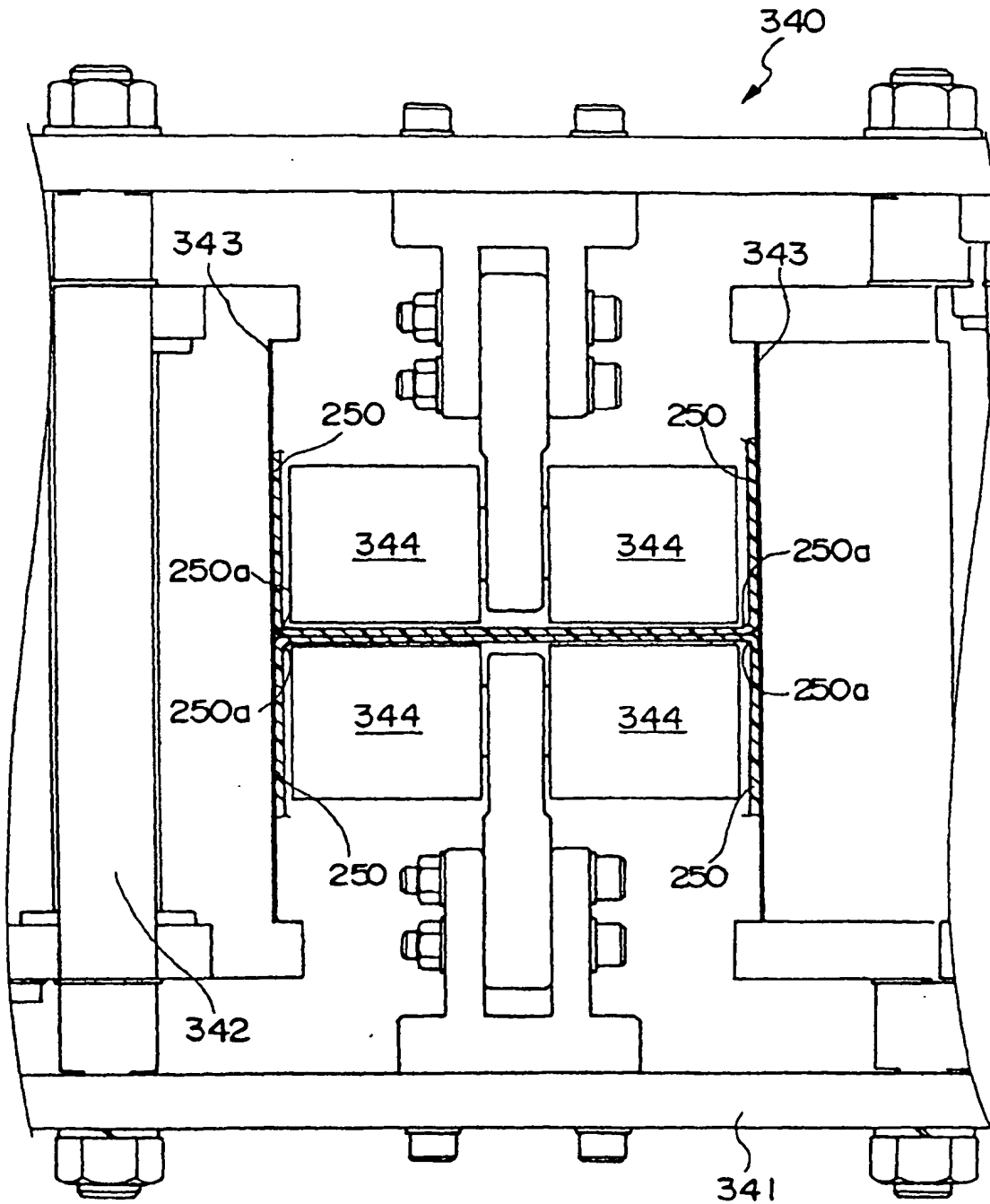


Fig. 9

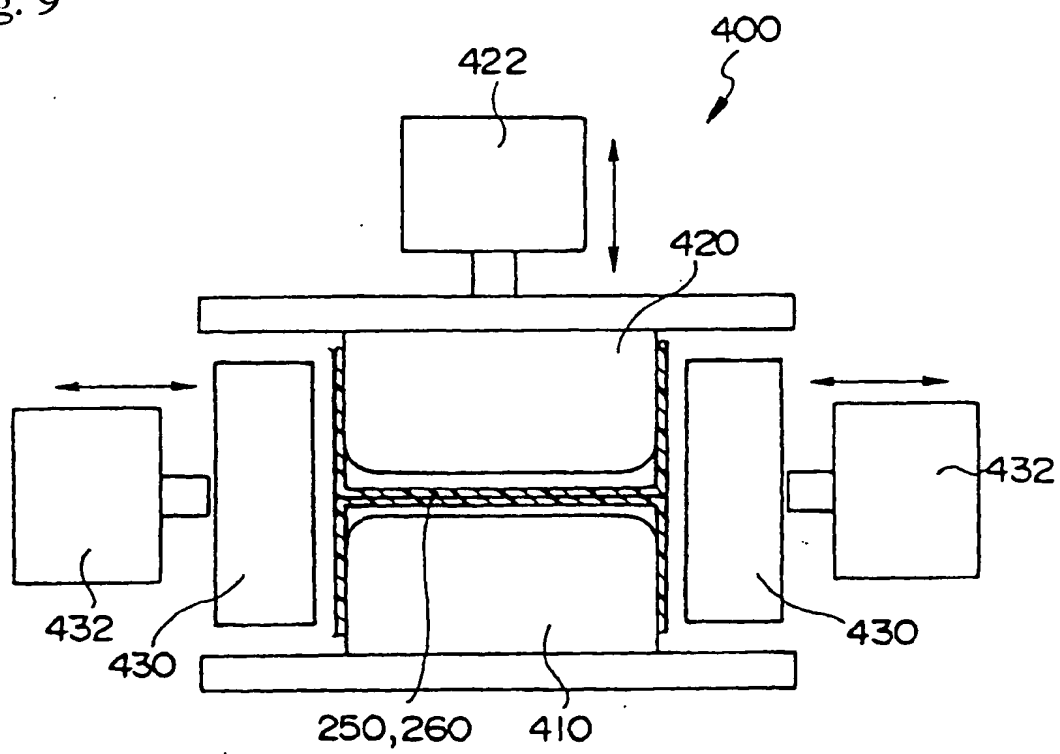


Fig. 10

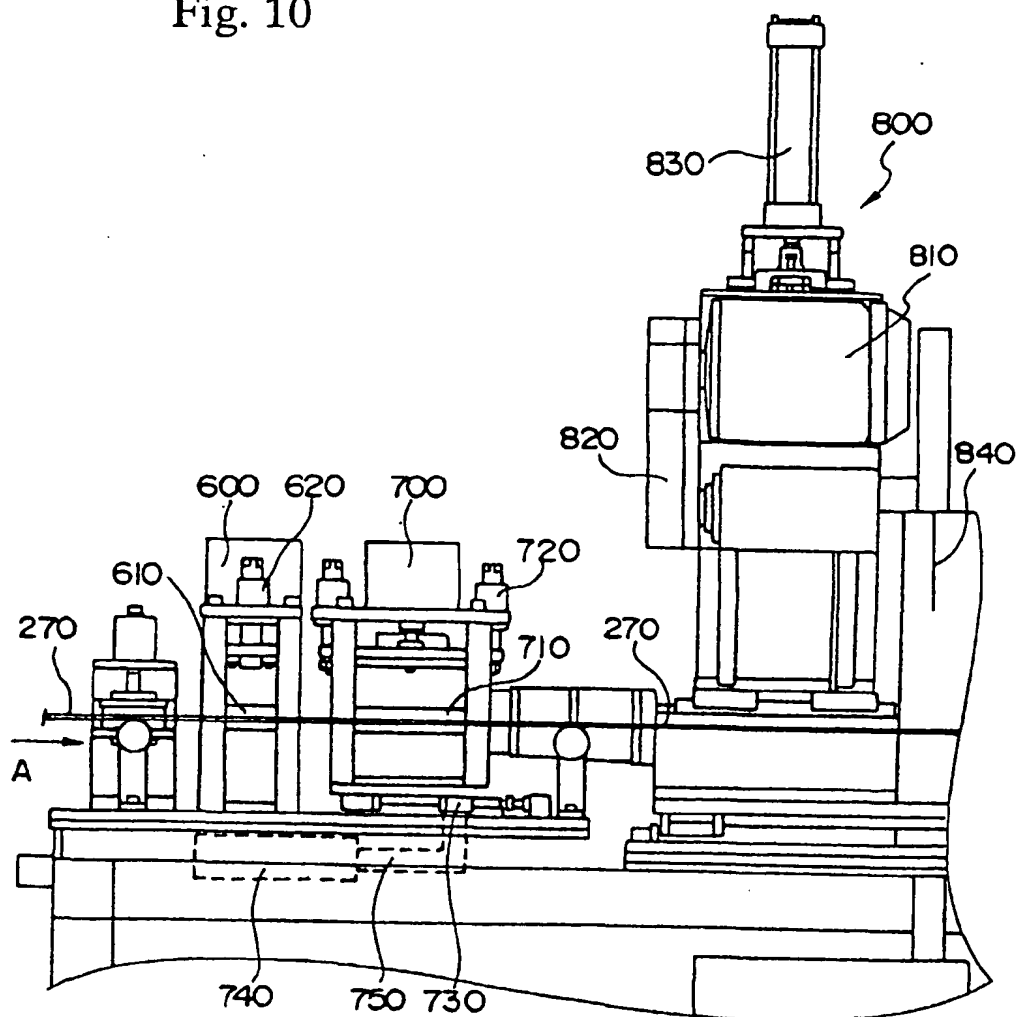
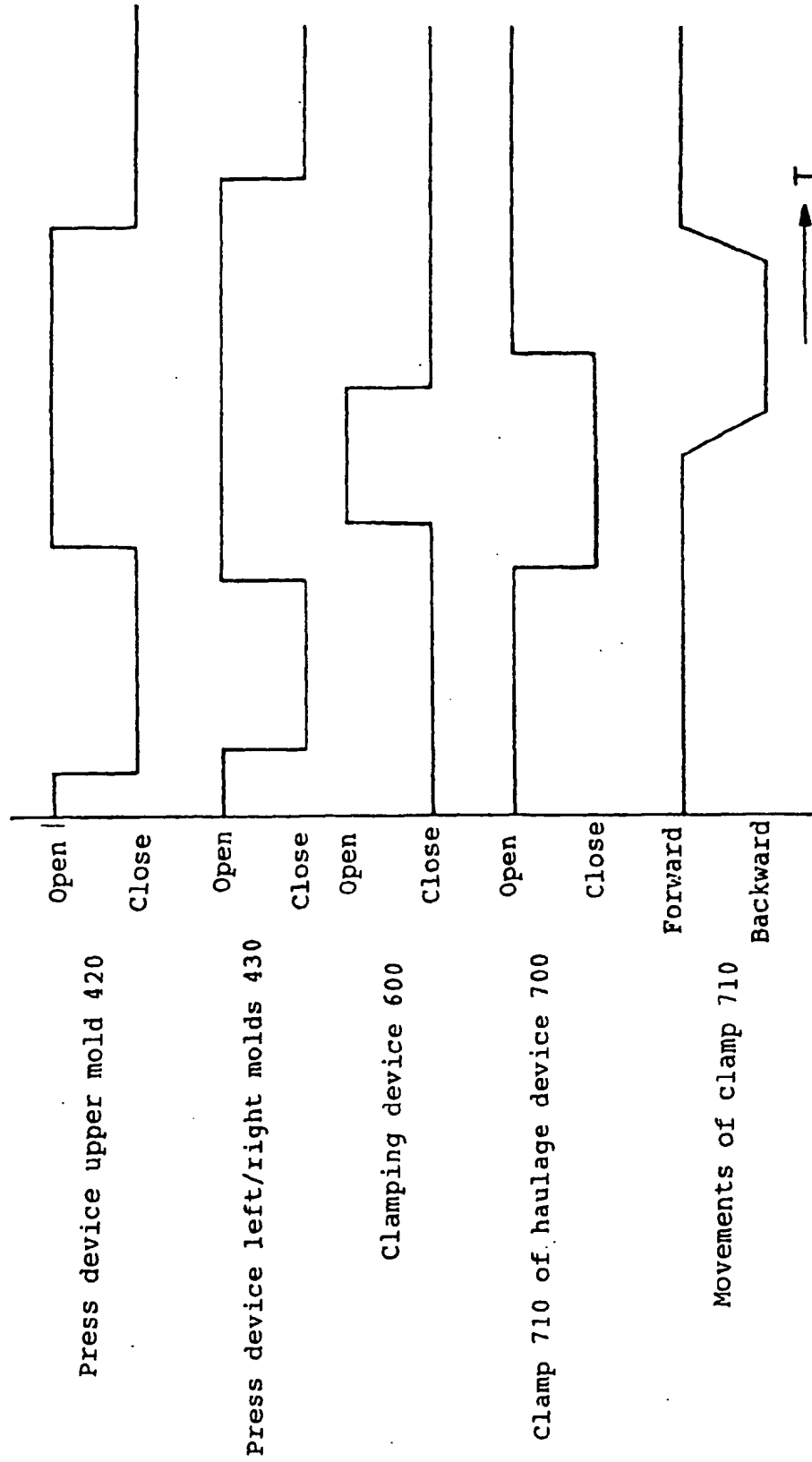
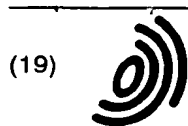


Fig. 11





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(11) **EP 1 116 575 A3**

(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:  
12.06.2002 Bulletin 2002/24

(51) Int Cl.7: **B29C 70/52, B29C 70/50**

(43) Date of publication A2:  
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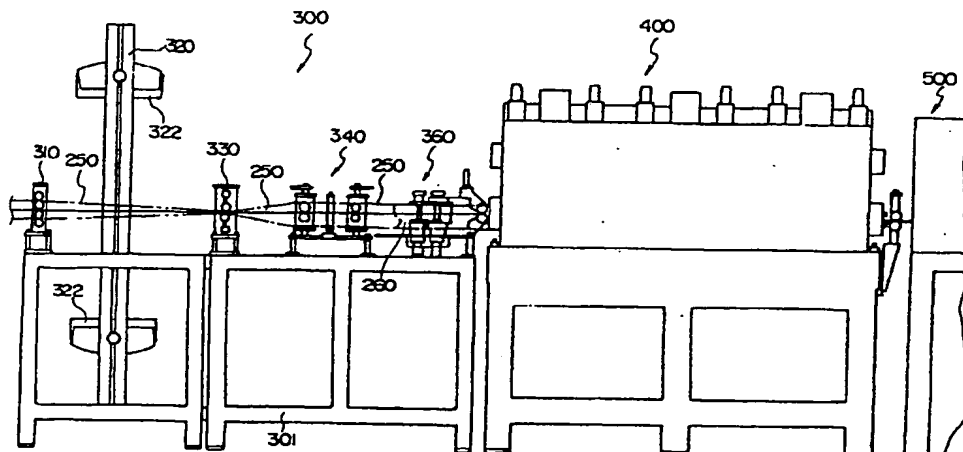
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(54) **Continuous forming device of h-shaped frp member**

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member to form the shape of an H, and to the surfaces of said H-shaped member are provided release films (260) before the member is transferred to a hot press device (400). Said sheet material heated and pressed by the hot press device (400) is then heated for a predetermined time at an after-cure device, where thermosetting of the material is completed. The produced H-shaped member is then intermittently pulled out by a haulage device and cut into predetermined lengths.

Fig. 5



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# EUROPEAN SEARCH REPORT

Application Number  
EP 01 10 0389

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Place of search THE HAGUE		Date of completion of the search 17 April 2002	Examiner Attalla, G
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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EP 01 10 0389

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